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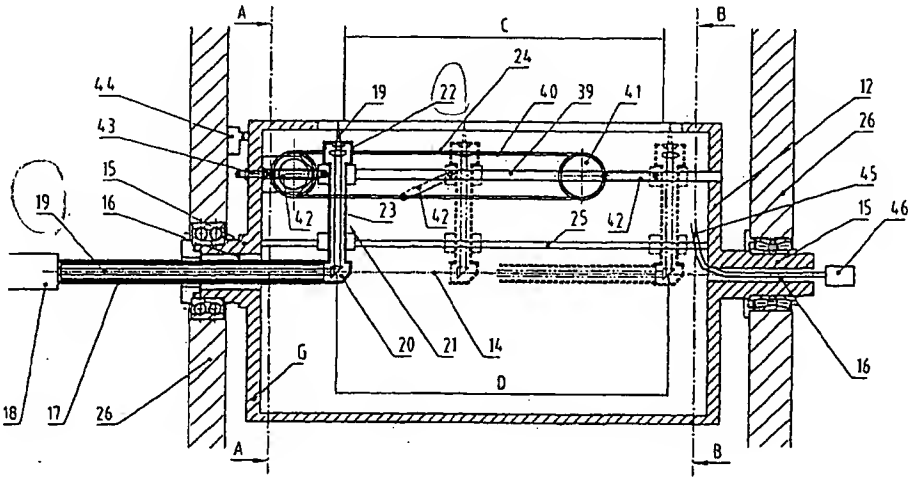

(57) Abstract

A device for cutting or perforating one or more webs of material (1) arranged on top of one another comprises a laser beam (19) that is angled and passes through an optical device (22). The device comprises a drum (12) with a slot (13) which is parallel to the axis of rotation (14) of the drum (12). The drum (12) rotates at a peripheral speed corresponding to the speed of the web of material (1) which is bent round the drum (12). The laser beam (19) extends into the drum, aligned with the axis of rotation (14) of the drum (12), and is angled and conducted out through the cutting device (21) which is arranged inside the drum (12). The cutting device (21) is reciprocable along a guide (25), so that the cutting device (21) cuts along the slot (13) where the web of material (1) is accessible. The laser beam is conducted through a casing (17, 23).

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DEVICE FOR CUTTING AND PERFORATING OF A WEB OF MATERIAL

The present invention relates to a device for cutting or perforating webs of material, more particularly a device which comprises at least one laser which emits a laser beam that passes through an optical device and is angled by means of an angling device.

Technical Background

When printing paper webs, for instance, to produce newspapers, the paper web has to be cut in exact cutting lengths, i.e. pieces of paper. This takes place in a folding machine where the printed paper web is usually folded, cut and folded together in different manners.

The cutting takes place instantaneously by means of a web-breaking roller which is equipped with a blade which strikes against a cylinder, round which the paper web is bent.

There is a loud noise as the paper web is "broken" off and, moreover, vibrations arise, which results in a poor working environment as well as a risk of defects and inaccuracies.

The blade has a toothed edge, which results in a serrated and ugly cutting edge which, furthermore, when cutting spreads particles of paper, which also contributes to a poor working environment.

To be able to adjust the position where cutting should take place along the paper web, new toothing of the cylinders involved is required or the paper web has to pass through a so-called registering device where the length of the paper web between printing rollers and cutting can be adjusted.

A solution to some of these problems would be to cut by means of a laser.

EP 0 443 646 discloses a method of cutting the paper webs by means of a laser. This publication discloses a method and a device for cutting or perforating a paper web by means of a laser beam. The paper web is forced to run along a bent, stationary plate, the form of which is such that the distance between the laser optics of the device and the paper web is substantially constant in the radial direction. The laser beam is angled by means of the laser optics which is arranged opposite the bent plate so as to cut along an angled slot in the plate.

A difficulty in this technique is that the paper web can only have one fixed predetermined speed in order to obtain a cutting perpendicular to the machine direction.

Another difficulty in this technique is that the distance to the paper is not constant. Certainly, the distance is constant in the radial direction but this is not the case perpendicular to the machine direction of the paper web since the laser beam emanates from a point half-way between the edges of the paper web. This means that the laser beam has to be more energetic to be able to cut the paper further out towards the edges.

Furthermore, there is a great risk of fire involved in this method.

Summary of the Invention

One object of the present invention is to provide a good environment in printing houses, on the one hand as regards noise and, on the other hand, as to the formation of dust when cutting paper webs.

Another object of the present invention is to provide finer cutting edges when cutting webs of material.

Yet another object of the present invention is to provide space for cutting webs of material at different speeds.

Furthermore, it is an object of the present invention to be able to easily provide an adjustment of the location of cutting on the web of material.

Besides, it is an object of the present invention to cut the web of material by using optimal laser-beam energy.

Finally, it is an object of the present invention to decrease the risk of fire when cutting by means of a laser beam.

According to the invention, these objects are achieved by a device as stated by way of introduction, the device being characterised by a drum which is provided with at least one slot parallel to the axis of rotation of the drum which rotates at a peripheral speed corresponding to the speed of the web of material which is bent round the drum, is temporarily attached to the drum with the aid of attaching means and abuts against a portion of the outside of the drum, at least one cutting device which is displaceably arranged inside the drum and is reciprocable, with the aid of a means attached to the drum, along at least one guide which is fixedly attached to the drum, extends parallel to the axis of rotation of the drum and is placed in such a manner that the cutting device/cutting devices cut along the slot/slots, an extensible casing which conducts said laser beam and which extends from the laser device into the centre of rotation of the drum and is aligned with the axis of rotation of the drum to at least one angling device for angling and optionally splitting up the laser beam, which subsequently is conducted out through the cutting device/cutting devices so that the laser beam cuts the portion of the web of material which is accessible in the slot, and a casing intended for the cutting device and extending from the angling device to the optical device.

This solution is advantageous because the cutting can take place at a higher speed and be adjusted more easily than with the corresponding mechanical method (see

above about new toothing). Besides, the adjustment may occur while in operation, which was previously not possible.

With one cutting device only inside the drum, both the speed of rotation of the drum and the length of the cut web of material may be freely chosen.

Having the same diameter of the cylinder as in the embodiment with one cutting device, several pieces of web of material per revolution can be cut or, for instance, the circumference of the cylinder can be doubled and the speed of rotation of the drum halved.

By masking the slot/slots with a perforated plate, perforation of the web of material can easily be provided.

Brief Description of the Drawings

Preferred embodiments of the invention will now be described by way of example and with reference to the accompanying drawings, in which

Fig. 1 shows a prior-art cutting technique in a folding machine,

Fig. 2 is a sectional view of a first embodiment of the present invention with a cutting device transversely of the machine direction of the paper web,

Fig. 3 is a cross-sectional view of the embodiment in Fig. 2 along the line A-A,

Fig. 4 is a cross-sectional view of the embodiment in Fig. 2 along the line B-B,

Fig 5 is a view of a second embodiment of the present invention comprising a cutting device, the view being similar to that in Fig. 2,

Fig. 6 is a cross-sectional view of the embodiment in Fig. 5 along the line A-A,

Fig. 7 is a cross-sectional view of the embodiment in Fig. 5 along the line B-B,

Fig. 8 shows a detail of the embodiment in Fig. 5,

Fig. 9 is a view of a third embodiment of the present invention comprising several cutting devices, the view being similar to that in Fig. 2,

Fig. 10 is a cross-sectional view of the embodiment in Fig. 9 along the line A-A,

Fig. 11 is a cross-sectional view of the embodiment in Fig. 9 along the line B-B,

Fig. 12 is a view of a fourth embodiment of the present invention comprising several cutting devices, the view being similar to that in Fig. 2,

Fig. 13 is a cross-sectional view of the embodiment in Fig. 12 along the line A-A,

Fig. 14 is a cross-sectional view of the embodiment in Fig. 12 along the line B-B, and

Fig. 15 shows an alternative detail in the first embodiment in Fig. 2.

Description of Preferred Embodiments

Fig. 1 illustrates prior-art technique in a printing house where the printed paper web 1 comes from printing machines (not shown) and is passed by means of guide rolls 2 and pull rolls 3 to a folding cylinder 4. In the folding cylinder 4, gripping means 5 are arranged in the form of extensible pins, which are controlled by cams so as to keep the leading edge of the intended piece of paper in place. A web-breaking roller 6 rotates synchronously with the folding cylinder 4 and "breaks" the paper web by means of a blade 28, just before the gripping means 5, against a buffer 7 arranged in the folding cylinder 4. The piece of paper P that has been cut off accompanies the folding cylinder 4 and an insert knife 8 protrudes, which is also controlled by cams, so that a gripping cylinder 9 which is provided with tongs 10 can grip the cut-off piece of paper P and, thus, fold it perpendicular to the machine direction.

According to the invention, the paper web is cut by means of a laser. This is accomplished by the folding cylinder 4 being replaced by another folding cylinder 11 according to the invention. The folding cylinder 11 also comprises gripping means 5 and at least one insert knife 8 along its periphery.

Figs 2, 3 and 4 show the folding cylinder 11 according to a first embodiment. The folding cylinder 11 comprises a drum 12 which is provided with a slot 13 which is arranged parallel to the axis of rotation 14 of the drum. The drum 12 is rotated at a peripheral speed corresponding to the running speed of the paper web 1 and the paper web 1 is bent round the drum 12. Compare with the prior-art technique shown in Fig. 1. The drum 12 is at its ends provided with protruding stub shafts 15 which are mounted in bearings in supporting means 26, the stub shafts 15 having a longitudinal cavity 16, through which, on the one side, an extensible casing 17 can extend, for instance, telescopically, and, on the other side, cables can be laid for current supply to a motor 38 and supply of signals from a position transducer 43 for a cutting device 21.

A laser device 18 which is connected to the casing 17 emits a laser beam 19 which is conducted through the casing 17 to an angling device 20 which angles the laser beam 19 towards the periphery of the drum 12 and through a cutting device 21. The laser device 18 can be of the type that emits a continuous or pulsed laser light.

The angling device 20 comprises a mirror or a prism for angling of the laser beam 19, preferably through 90 degrees, but other angles are also possible.

The cutting device 21 comprises an optical device 22 with at least one lens that concentrates the laser beam so that the focus is on the paper web or webs which is/are accessible in the slot 13, because it is also possible to simultaneously cut paper webs that are placed on top of one another. A casing 23 for the laser beam 19 ex-

tends from the angling device 20 to the optical device 22. The optical device 22 may be placed anywhere along the cutting device 21 but preferably as close to the periphery of the drum 12 as possible.

The casings 17 and 23 form a gas-proof unit, through which gas can be conducted from the laser to the paper web.

The laser beam has intentionally a large cross-section area so as not to unnecessarily heat the casings 17, 23 and the angling device 20 and, thus, the inside of the drum 12. When the laser beam is later concentrated, the amount of energy in focus will be so large that the laser beam burns a hole in the paper web. To protect the paper from catching fire, use is made of a protective gas, such as inert gas, which is conducted through the casings 17, 23.

The cutting device 21 is reciprocable along the slot 13 with the aid of a means 24 which will be described in more detail below. A guide 25, which is fixedly attached to the end walls G of the drum 12, extends parallel to the axis of rotation 14 of the drum 12 at a distance from the slot 13. The guide 25 guides the cutting device 21 when moving, so that the laser beam 19 can cut off the paper web 1 along the slot 13. The guide 25 can also be formed as a slotted cylinder which is arranged coaxially to the axis of rotation of the drum 12 so that the casing 17 with the angling device 20 is guided inside the cylinder and the cutting device 21 protrudes through the slot of the cylinder (not shown).

Since the cutting device 21 follows the rotation of the drum 12 while at the same time the paper web 1 steadily abuts against a part of the outside of the drum 12 during a period of time, the cutting device 21 has time to move and, thus, cut along the slot 13 so that the paper web 1 is cut off perpendicular to its machine direction. The speed of the cutting device 21 along the slot 13 must be adapted to the speed of the paper web 1 so

that the cutting device 21 has time to cut along the entire width C of the paper web before the paper leaves the roll.

Cutting takes place either during the reciprocating motion of the cutting device 21 or when moving in one direction only, the cutting device 21 being moved back to the initial position after cutting.

The width C of the web of material 1 and the travelling distance D of the cutting device are shown in Fig. 2. Here the motion of the cutting device 21 is also shown by means of a position where the cutting device 21 is indicated with full lines and two other positions during the motion where the cutting device 21 is indicated with dashed lines.

The displacement of the cutting device 21 may occur in many ways. In this embodiment a displacement means 24 for the cutting device 21 is shown, which comprises an electric motor 38, a guide 39 and an endless belt 40, for instance, a toothed belt or a chain. Two toothed deflecting rollers or terminal rollers 41 are arranged at a distance from one another on the guide 39. The guide 39 is fixedly attached between the end walls G of the drum 12 parallel to the axis of rotation 14 of the drum 12 and the motor is fixedly attached to the drum 12. The endless belt 40 is laid between the terminal rollers 41 and the electric motor 38 continuously drives the endless belt 40 by means of one of the toothed terminal rollers 41.

As previously mentioned, the motor 38 is supplied with electricity by cables 45 which enter the cavity 16 in the stub shaft 15, see Fig. 2 to the right. The cables can be attached to the inside of the circumferential surface of the drum 12. A collector 46 is arranged in the cavity 16 in the stub shaft 15 for supplying power to the motor in the rotating drum 12.

On the endless belt 40, a link 42 is arranged, which is attached between the endless belt 40 and the cutting device 21. When the endless belt is driven by the elec-

tric motor 38, the link 42 pulls the cutting device 21 along the guides 25, 39 to one terminal roller 41. As the link 42 passes the position which is furthest away from the cutting device 21, it starts, in return, pushing the cutting device 21 ahead of itself towards the second terminal roller 41 until the link 42 passes the position that is furthest away from the cutting device 21 at the second terminal roller 41, after which the link 42 once again pulls the cutting device 21. Thus, the cutting device 21 is moved along the slot 13 of the drum 12.

One alternative (see Fig. 15) to using a link 42 is attaching a block 47, which is provided with a vertical recess 48, to the cutting device 21, the ends of the recess 48 being aligned with the endless belt 40. A pin 49 is attached to the endless belt 40 and protrudes into the recess 48 in order to pull/push the cutting device 21 back and forth. At the terminal rollers 41 the pin 49 is forced towards the other end of the recess 48.

To set the position exactly for the cutting, the drum 12 is rotated in an infinitely variable manner in relation to the paper web 1 until the correct positioning of the cutting line has been achieved. This occurs by the speed of rotation of the drum temporarily being increased or decreased. To control the setting and the operation, a first sensor 43 is arranged on the drum 12 in the vicinity of the displacement means 24 to indicate the position of the cutting device 21 and a second sensor 44 is arranged on the supporting means 26 to indicate the angular position of the drum 12. The signals from these sensors 43, 44 are processed in a control unit (not shown).

In a second embodiment of the invention, an alternative embodiment of the displacement means 24 is shown, see Figs 5-8, which comprises a planetary gear 30, a reel-type shaft 31 and a casing 32 for the planetary gear 30. A gear rim 33 is fixedly attached to the supporting means 26 and is arranged in bearings on the stub shaft 15 by means of, for instance, a needle bearing 34.

The reel-type shaft 31 is rotatably arranged between the end walls G of the drum 12 parallel to the axis of rotation 14 of the drum 12. One end of the reel-type shaft 31 is mounted in bearings in one of the end walls and its other end extends through the opposite end wall and has a gear wheel 35 fixedly attached thereto. This gear wheel 35 can directly engage the gear rim 33 or a gear wheel 36 can be rotatably mounted on the drum 12 between the gear wheel 35 and the gear rim 33.

The reel-type shaft 31 is rotated by the drum 12 being rotated by means of a motor (not shown), which implies that the gear wheel 36, which is arranged on the rotating drum 12, is rotated by engaging the idle gear rim 33 and, thus, accompanies the gear rim 33 as the drum rotates. The gear wheel 36 rotates, in its turn, the gear wheel 35 which is attached to the reel-type shaft 31.

Alternatively, an external gear rim with an internal toothing which encloses the gear wheel 35 and a gear wheel 36, if any, can be attached to the support instead of the internal gear rim 33 (not shown).

The reel-type shaft 31 is provided with two continuous intersecting notches 37 with a pitch of, for instance, ±45 degrees, which, in the ends, changes to 90 degrees for reversing. The cutting device 21 is arranged on the reel-type shaft 31 by means of a pin 50 which is "banana-shaped" in cross-section and follows the notches 37 in such a manner that when the reel-type shaft 31 rotates, the cutting device 21 is moved along the reel-type shaft 31 until it reaches the 90-degree pitch where the cutting device 21 turns and is moved back along the reel-type shaft 31.

Instead of the reel-type shaft 31, a smooth shaft can be used, in which case an inclined rubber wheel which is in contact with the shaft and is rotatably arranged on the cutting device 21 is driven by the shaft to move the cutting device 21 to one side. In the end of the shaft is a turning means which inclines the rubber wheel to the

other side so that the shaft drives the rubber wheel and, thus, the cutting device 21 to the other side (not shown).

A lubricating device (not shown) for lubricating the planetary gear 30 is arranged inside the casing 32.

Adjustments can only be carried out within the scope of the gear ratio of the planetary gear 30 and the pitch of the notches 37 of the reel-type shaft 31.

Figs 9, 10 and 11 show a third embodiment of the present invention with more than one cutting device 21, more particularly two, but it goes without saying that more of them can be arranged. The drum 12 comprises a corresponding number of slots 13, displacement means 24 and guide means 25.

In this embodiment the angling device 20 further comprises splitting optics 27 for splitting up the laser beam 19 into a number of beams which corresponds to the number of cutting devices 21. The splitting optics 27 comprises mirrors or prisms. In this embodiment the first part of the casing 17 does not need to be extensible but the following parts of the casing 17 which are arranged after the splitting optics 27 have to. The displacement means 24 works as described in the first embodiment.

When the first cutting device 21 has just cut the web of material 1, the second cutting device 21 has cut half the width of the web of material 1. The cutting devices 21 cut with a time lag relative to one another.

Figs 12, 13 and 14 show a fourth embodiment of the invention. This embodiment works as the third embodiment apart from the fact that it uses a displacement means 24 according to the second embodiment, that is a planetary gear 30 and a reel-type shaft 31.

By providing the drum 12 with a masking plate formed with perforations (not shown) which covers the slot 13, the paper web can be perforated instead of cut. Perforation of the paper web can also occur by means of a pulse laser which emits laser pulses at predetermined points of

time that are adapted to the speed of rotation and the speed of the cutting device.

Naturally, also a linear motor can be used to move the cutting device 21.

The described features can be combined in different ways and not only in the combinations mentioned in the description.

Even if this description is aimed at a printing application, the device and method according to the present invention can, of course, be used within other techniques than the printing technique. For instance, webs of certain plastics, plastic-coated materials, such as paper or textile fabric, or textile fabrics could be cut.

The invention is thus not restricted to what has been described above and shown in the drawings, and can be modified within the scope of the claims.

CLAIMS

1. A device for cutting or perforating one or more webs of material (1) arranged on top of one another, comprising at least one laser device (18) which emits a laser beam (19) that is angled by means of an angling device (20) and passes through an optical device (22), characterised by

a drum (12) which is provided with at least one slot (13) parallel to the axis of rotation (14) of the drum (12) which rotates at a peripheral speed corresponding to the speed of the web of material (1) which is bent round the drum (12), is temporarily attached to the drum (12) with the aid of attaching means (5) and abuts against a portion of the outside of the drum (12),

at least one cutting device (21) which is displaceably arranged inside the drum (12) and is reciprocable, with the aid of a means (24) attached to the drum, along at least one guide (25) which is fixedly attached to the drum (12), extends parallel to the axis of rotation of the drum (12) and is placed in such a manner that the cutting device/cutting devices (21) cut along the slot/slots (13),

an extensible casing (17) which conducts said laser beam (19) and which extends from the laser device (18) into the centre of rotation of the drum (12) and is aligned with the axis of rotation (14) of the drum (12) to at least one angling device (20) for angling and optionally splitting up (27) the laser beam (19), which subsequently is conducted out through the cutting device/cutting devices (21) so that the laser beam (19) cuts the portion of the web of material (1) which is accessible in the slot (13), and

a casing (23) intended for the cutting device (21) and extending from the angling device (20) to the optical device (22).

2. A device as claimed in claim 1, wherein the cutting device (21) comprises an optical device (22) with at least one lens that concentrates the laser beam so that its focus is on the portion of the web/webs of material (1) which is accessible in the slot (13).

3. A device as claimed in claim 1 or 2, wherein the displacement device (24) comprises an endless belt (40) which is laid between two toothed terminal rollers (41) arranged at the turning-points of the cutting device (21), one of the terminal rollers (41) being driven by an electric motor (38) which is fixedly attached to the drum and, thus, driving the belt (40), a driving means (42, 47) which is arranged between the belt (40) and the cutting device (21), pushing and pulling the cutting device (21) back and forth along a guide (39) which is fixedly attached to the end walls (G) of the drum (12).

4. A device as claimed in claim 3, wherein the driving means (42, 47) between the belt (40) and the cutting device (21) is a link (42) which is attached to the belt (40) and the cutting device (21).

5. A device as claimed in claim 3, wherein the driving means (42, 47) between the belt (40) and the cutting device (21) is a block (47) which comprises a vertical recess (48), the ends of which are aligned with the height of the endless belt (40) and a pin (49) which is arranged on the belt (40) and which protrudes into the recess (48) and pulls the block (47) and, thus, the cutting device (21) along the guide (39).

6. A device as claimed in claim 1 or 2, wherein the displacement means (24) comprises a reel-type shaft (31) which is rotateably arranged between the end walls (G) of the drum (12), parallel to the axis of rotation (14) of

the drum (12), and a planetary gear (30) which is arranged at one of the end walls (G) of the drum (12), the reel-type shaft (31) being driven by the rotation of the drum (12) by means of the planetary gear (30) and a pin (50), which is arranged on the cutting device (21), slipping into the recess of the reel-type shaft (31) so that the rotation of the reel-type shaft (31) drives the cutting device (21) back and forth.

7. A device as claimed in any one of claims 1-6, wherein the guide (25) is a rod-like means and is fixedly attached to the end walls (G) of the drum (12).

8. A device as claimed in any one of claims 1-6, wherein the guide (25) comprises a slotted cylinder, which is coaxial to the axis of rotation (14) of the drum (12), the cutting device (21) sliding along the slot, and the slot of which is directed towards the slot (13) of the drum (12).

9. A device as claimed in any one of claims 1-8, wherein the two casings (17, 23) form a tight unit for conducting a fire-preventing gas from the laser device (18) to the actual cutting area.

10. A device as claimed in any one of claims 1-9, wherein the angling device (20) angles the laser beam (19) about 90 degrees in relation to the axis of rotation (14) of the drum (12).

11. A device as claimed in any one of claims 1-10, wherein the angling device (20) comprises at least one mirror or a prism.

12. A device as claimed in any one of the preceding claims, wherein the angling device (20) comprises a

splitting-up device (27) which has at least two mirrors or a prism.

13. A device as claimed in any one of the preceding claims, wherein the device is intended for a folding machine in a printing house.

Fig. 1

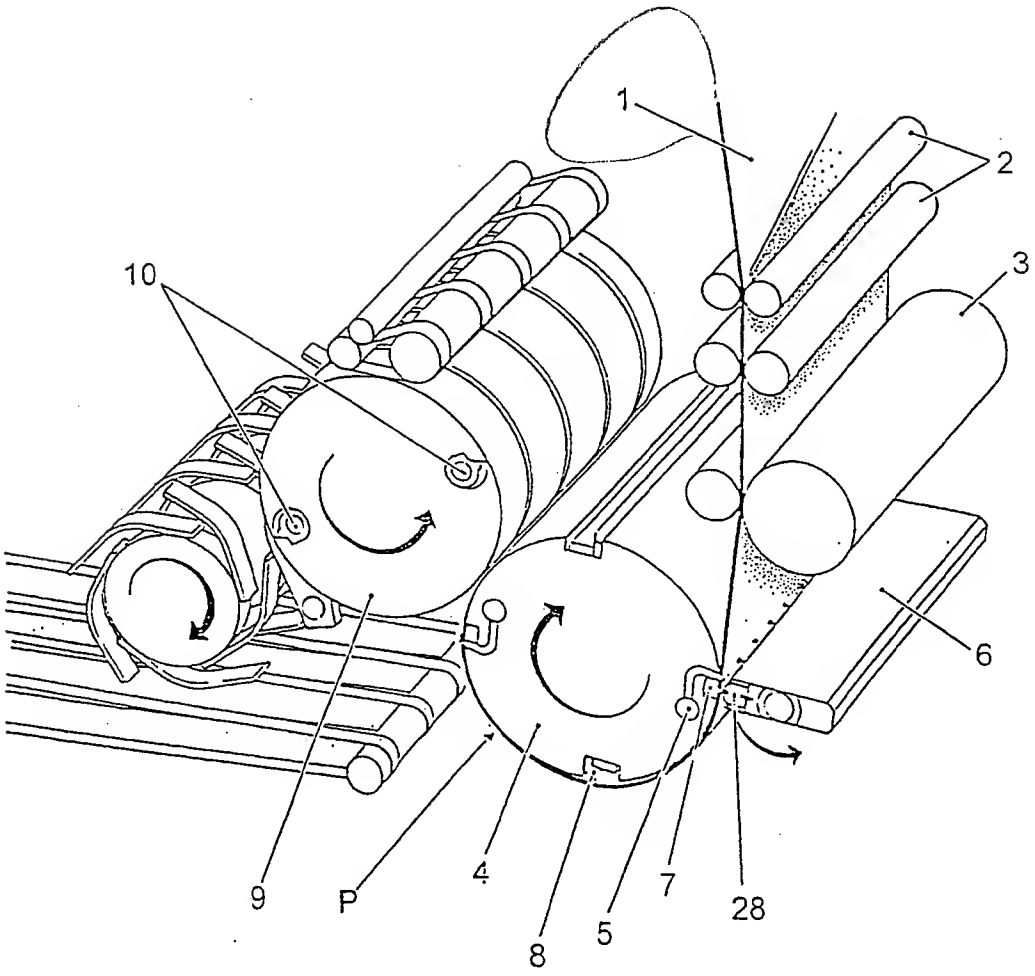
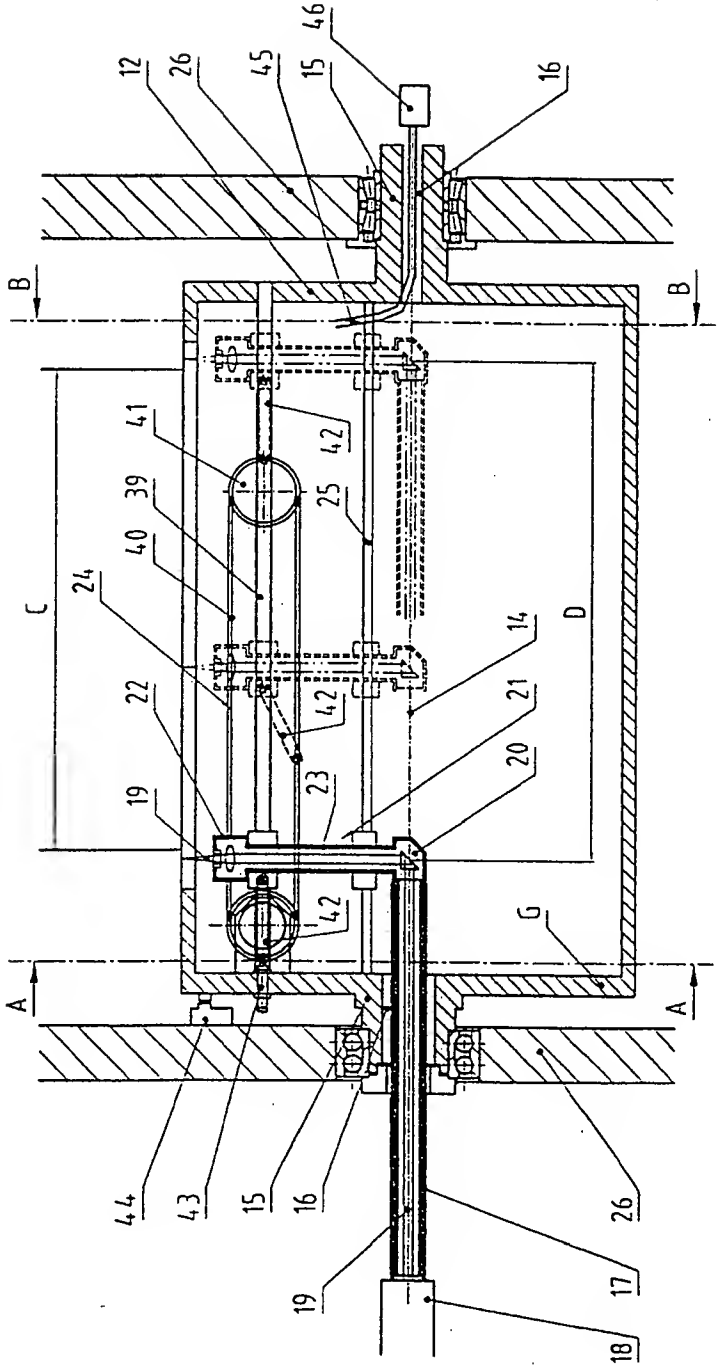


Fig 2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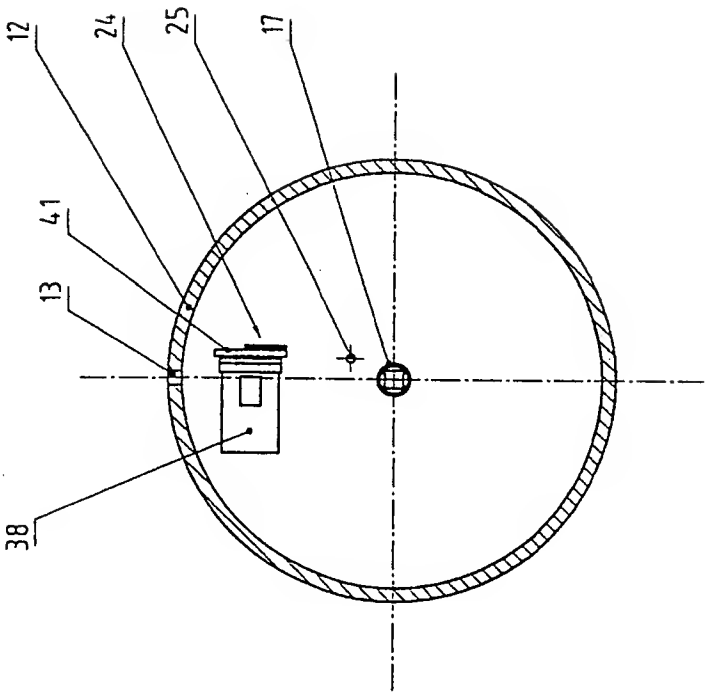


Fig 3
A - A

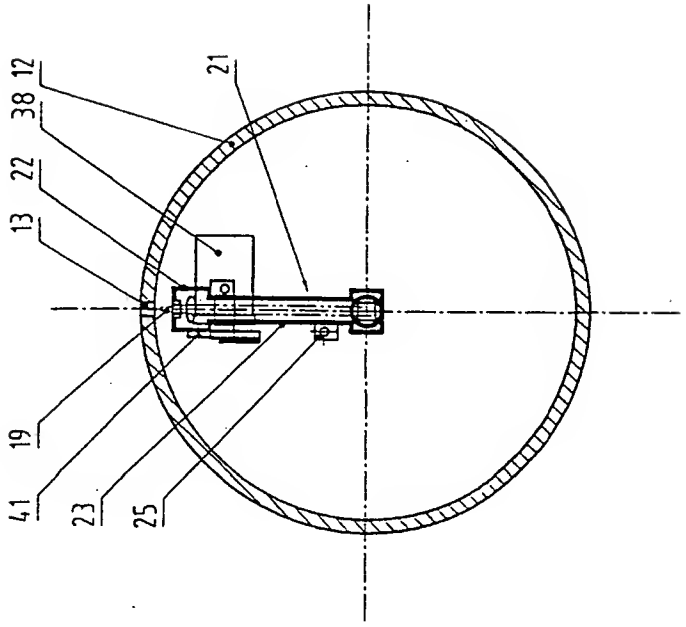
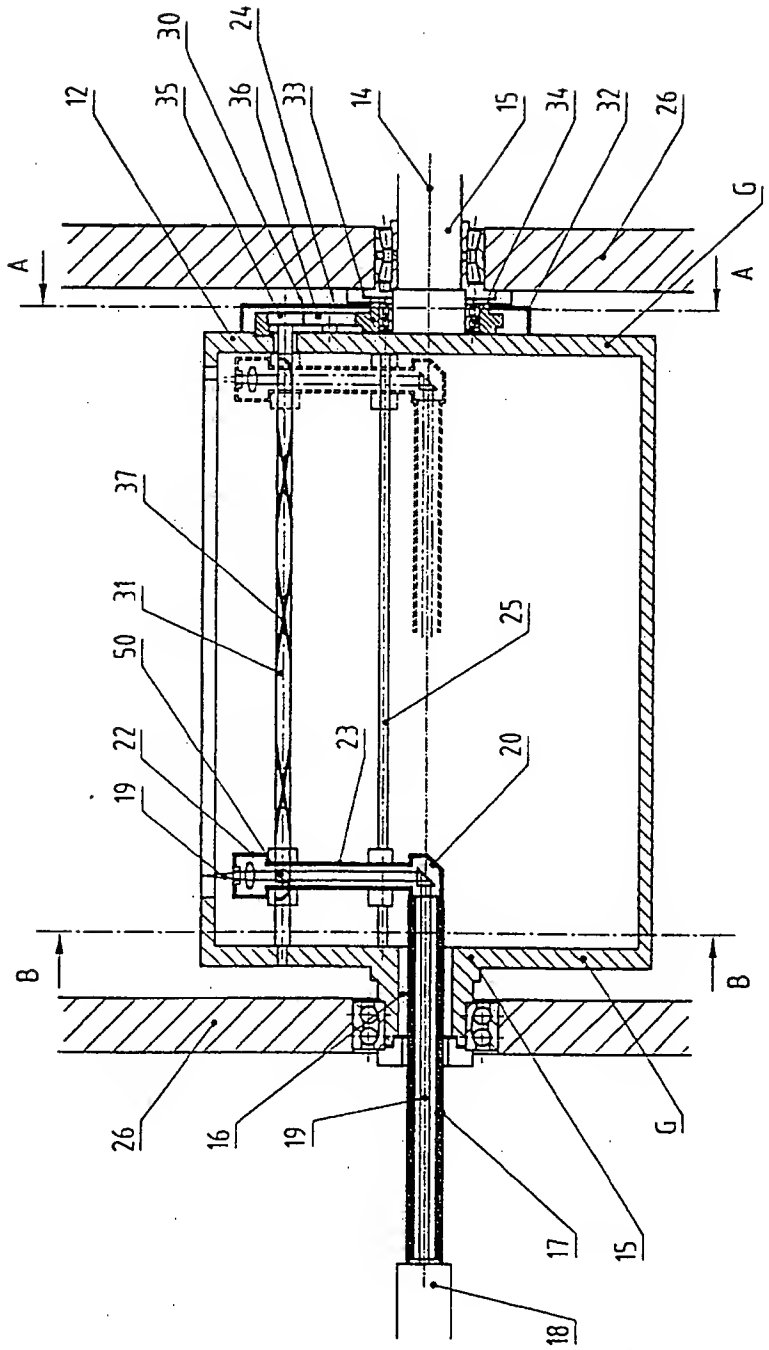


Fig 4
B - B

Fig 5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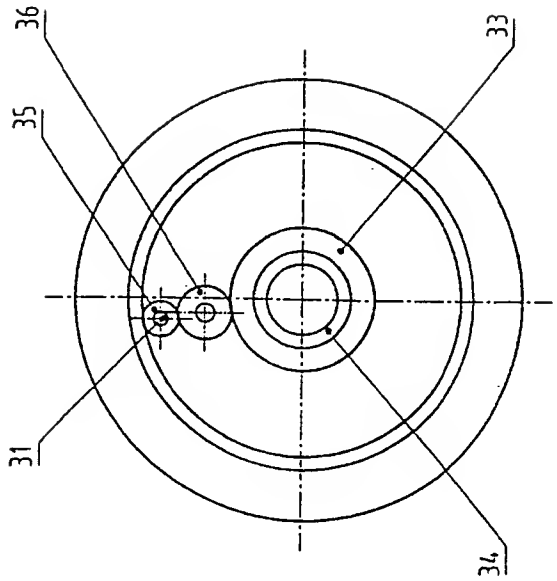

Fig 6
A - A

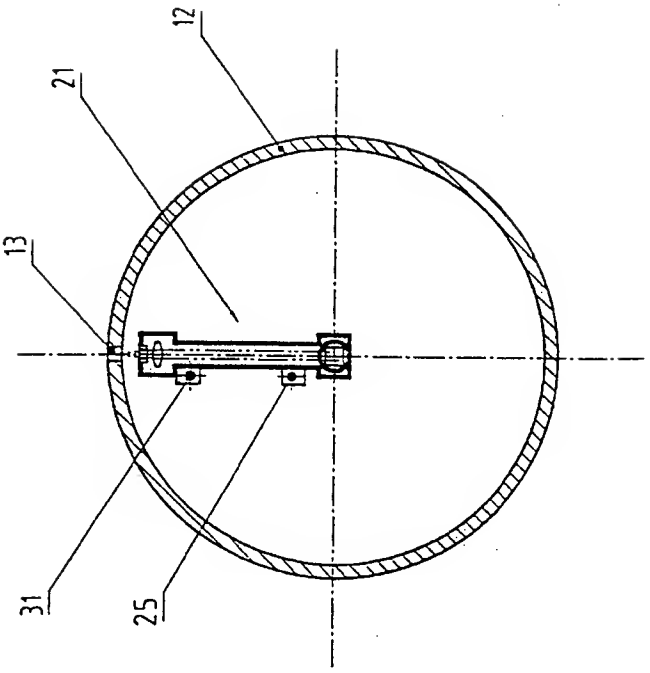

Fig 7
B - B

Fig 8

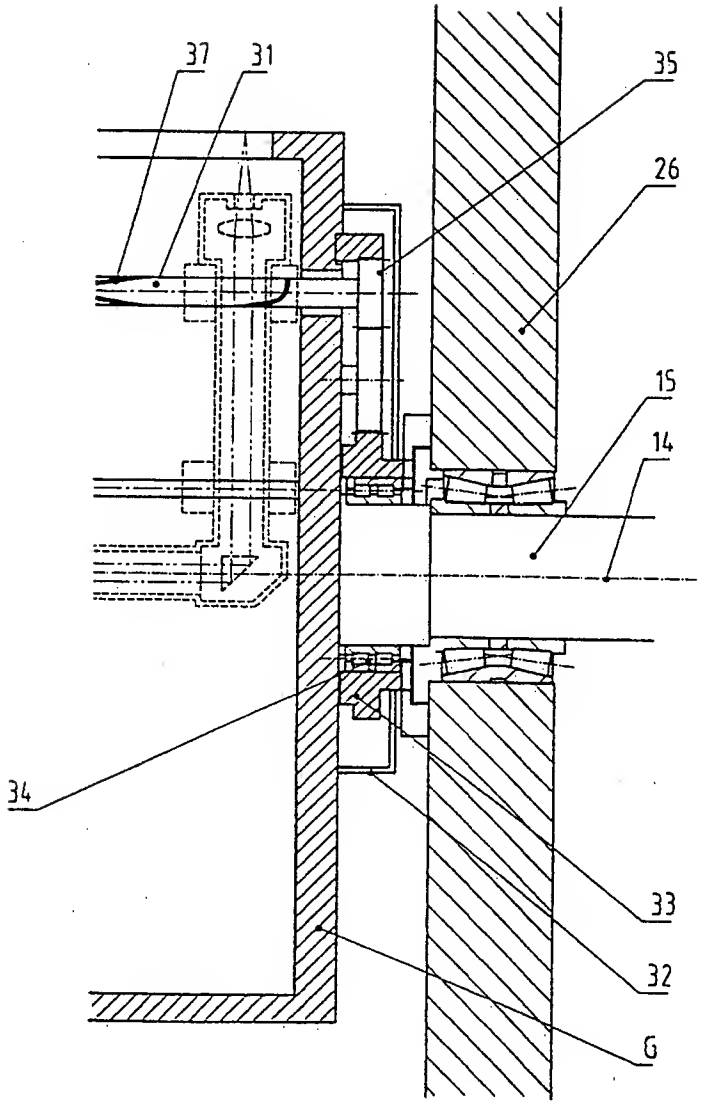

Fig 9

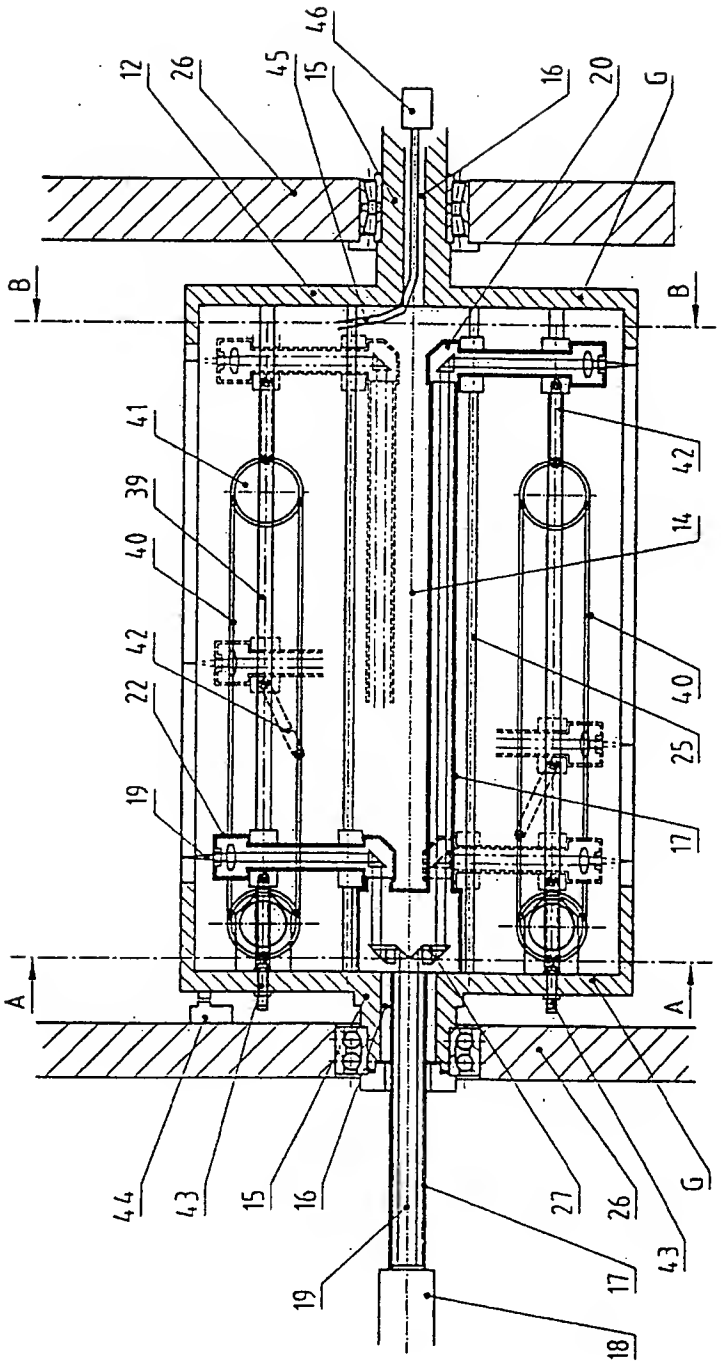
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Fig 10

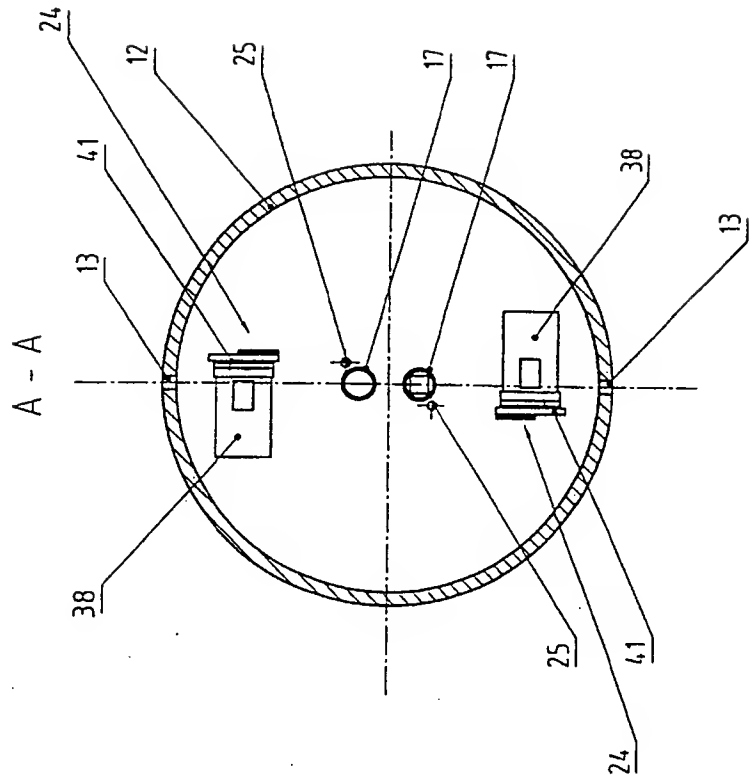
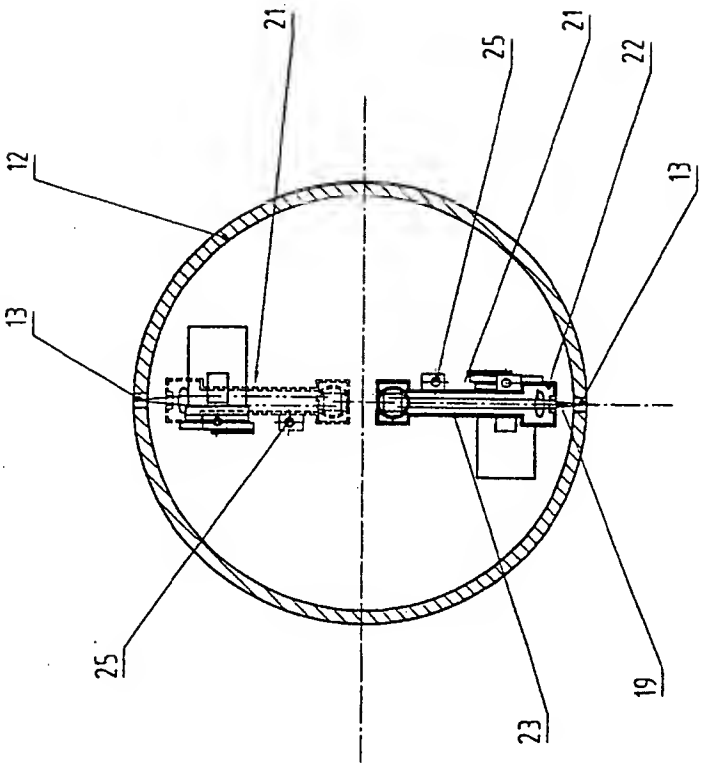
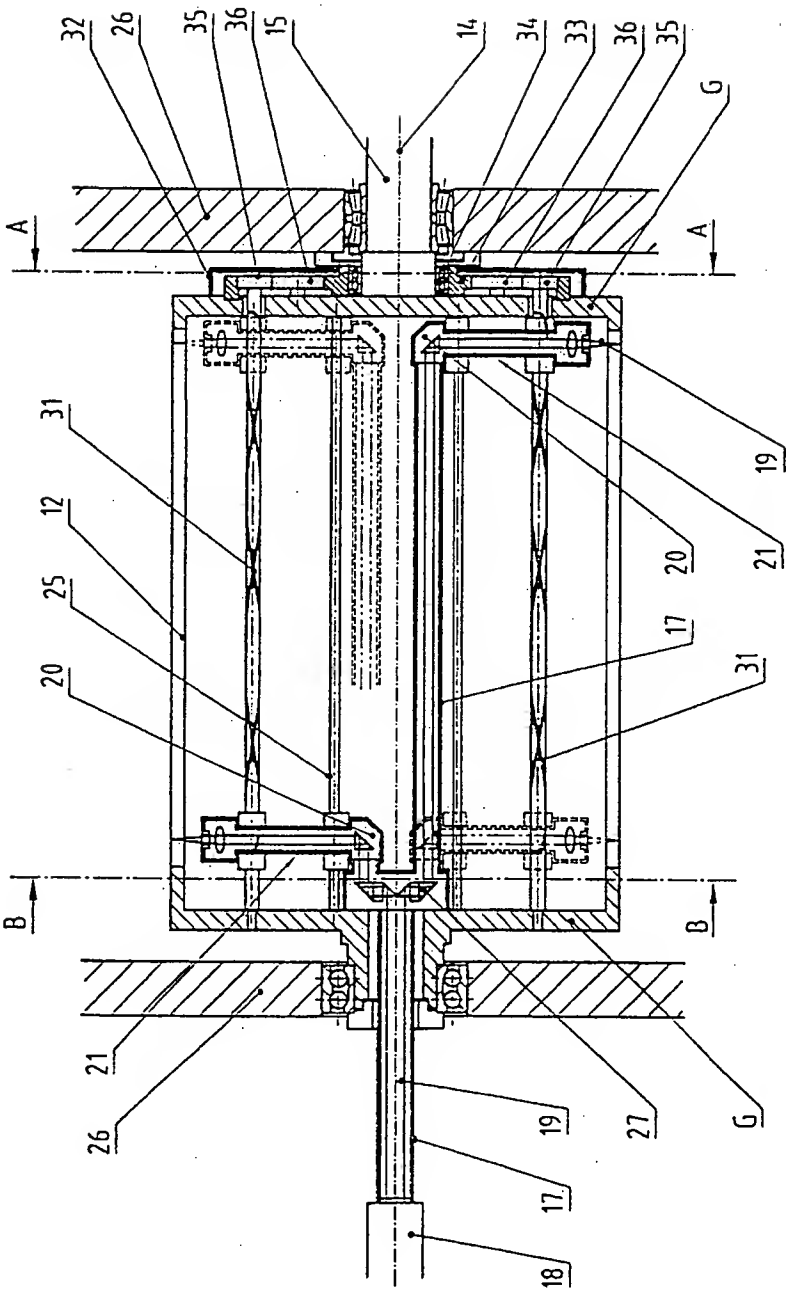


Fig 11
B - B

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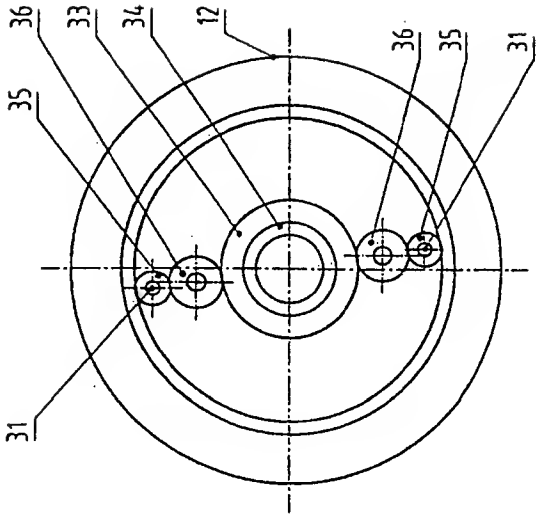


Fig 13
A - A

Fig 14
B - B

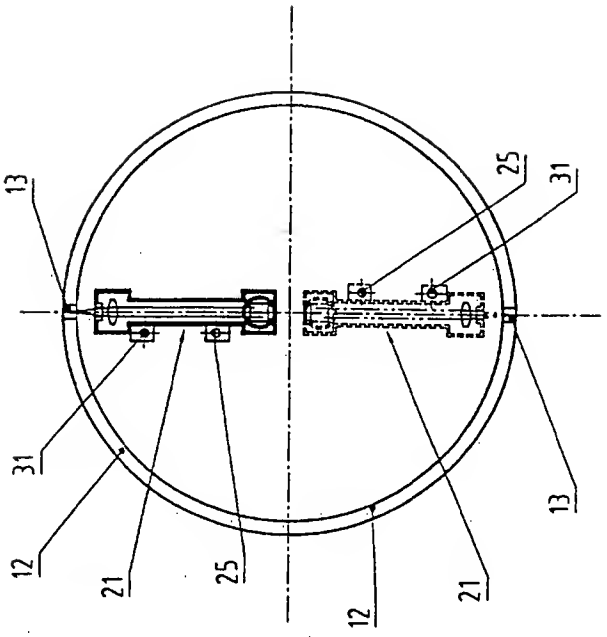
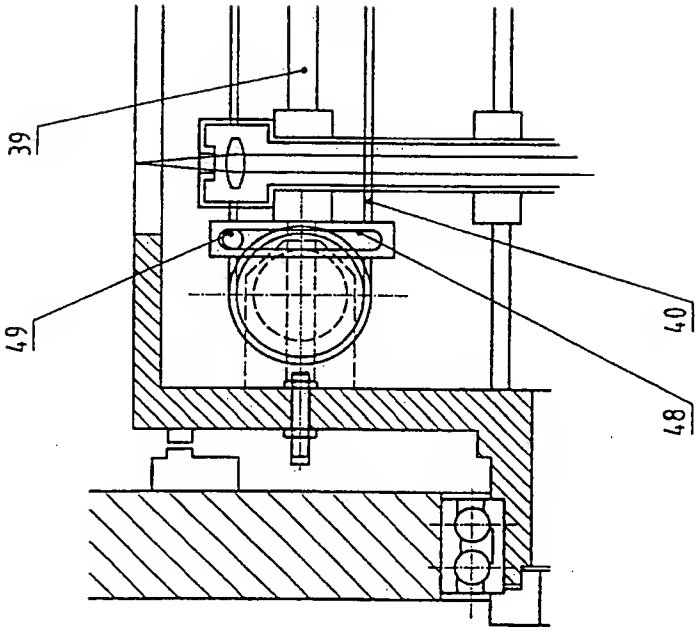


Fig 15



INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 99/02351

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B65H 35/04, B23K 26/08
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B65H, B23K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	FR 2740714 A1 (HEIDELBER HARRIS SA SOCIETE ANONYME ET AL), 9 May 1997 (09.05.97), figures 3-4, abstract --	1
A	US 5444210 A (F.D. BINGENER ET AL), 22 August 1995 (22.08.95), abstract -- --------	1

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 April 2000	25 -04- 2000
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Christer Falk / MR Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/SE 99/02351

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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US 5444210 A	22/08/95	DE 4235863 C	27/01/94
		DE 59300506 D	00/00/00
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